Journal of Computer and Education Research
December 2022 Volume 10 Issue 20 (ISSN:2148-2896)
http://dergipark.org.tr/jcer

Research Article

Mathematics Teachers' Evaluation of Digital Stories and Views

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Article Info

Received: *04 March 2022*
Accepted: *24 June 2022*

Keywords: Digital storytelling, evaluation, mathematics teacher, view

10.18009/jcer.1082591

Publication Language: English

Abstract

Different tools are used in the evaluation of digital stories. However, it is thought that the evaluations of the teachers are at least as important as the formal and technical evaluations. The aim of this study was to investigate middle school mathematics teachers' evaluations of 36 digital stories. Furthermore, at the end of the process, the aim was to examine their views on the use of digital stories in the learning environment. The participants were seven mathematics teachers. The data were analysed by content analysis. As a result of the research, it was seen that examples and mathematical activities were the most liked features of the digital stories. The least liked features were images, errors and examples. When the views of the teachers were examined, it was seen that all participants stated the need for digital stories in mathematics classes and wished to learn and use digital stories.

To cite this article: Aldemir-Engin, R. (2022). Mathematics teachers' evaluation of digital stories and views. *Journal of Computer and Education Research, 10* (20), 330-357. https://doi.org/10.18009/jcer.1082591

Introduction

With the emergence of new media, new tools have been created that can be used in environments that enable collaboration, co-authoring and sharing ideas and works of art with audiences (Pavlou, 2020). One of these tools is Digital Storytelling (DST). DST is an idea that emerged in the 1990s when digital technologies that were developed offered new tools for expression. A group of media artists and designers came together to explore how digital media could be utilised to enhance storytelling. In 1994, the San Francisco Digital Media Center was established with the collaboration of Dana Atchley, Joe Lambert, and Nina Mullen. In 2015 it was renamed StoryCenter. StoryCenter has worked with almost a thousand organisations around the world and trained more than fifteen thousand people in hundreds of workshops for them to share stories from their lives in various fields (StoryCenter, 2021).

In the most general sense, DST is the process of telling stories on a multimedia platform based on meaning-making, collaboration, and reinforcement of narratives (Schmier, 2021). It is possible to define a digital story (DS) as a clip, usually between three and five

minutes long, consisting of a series of still images combined with spoken and/or written text. Music is also used from time to time to arouse emotion (Bran, 2010). According to Albano and Pierri (2017), DST is concerned with adding various types of combined multimedia such as recorded audio, hypertexts, video clips, music, images, etc. to the ancient practice of storytelling. In other words, it is the art of discovering different media and software to communicate stories in new and powerful ways by using digital media (McLennan, 2006). DSs generally adopt a first-person narrative perspective, because DST allows people to create stories based on their own experiences and subjective understanding of a topic (Bran, 2010). With the development of computer usage and the emergence of the internet, DST has shown people that they can produce content and narratives without possessing any specialised skills, and that they can write stories about themselves or different situations. For this reason, the concept of DST has also turned into a mass movement (Dinçer, 2019). As a teaching and learning approach, DST has been proven to help create and build communities, to provide platforms for communication, and to reflect people's past (Condy, Chigona, Gachago, Ivala & Chigona, 2012).

While doing DST activities, it is necessary to adhere to certain principles. One of these is the DST elements. There are studies in the literature that define DST elements in different ways. Lambert et al (2003) defined these elements as point of view, a dramatic question, emotional content, the gift of your voice, the power of the soundtrack, economy, and pacing. Robin and Pierson (2005) stated these elements as the overall purpose of the story, the narrator's point of view, a dramatic question or questions, the choice of content, clarity of voice, pacing the narrative, use of a meaningful audio soundtrack, quality of the image, economy of the story detail, and good grammar and language usage. Lambert and Hessler (2018) expressed the components of DST as self-revelatory, personal or first-person voice, a lived experience of the author, images, soundtrack, length and design, and intention. The self-revelatory component is the expression of the purpose of the story by arousing a feeling of immediacy and curiosity. The voice element, on the other hand, is the emphasising of emotions while the story is being voiced. The experiential component is concerned with the transfer of experiences about the event experienced. The images component, on the other hand, is the preference for a small number of still images in the DS. The soundtrack component refers to making use of background music or ambient sound. The fact that the story is less than five minutes long, namely the length, and that special effects or emphasis

are used, namely the design, are examined within the scope of the length and design component. Formal choices about participation, distribution and ethics fall under the scope of the intention component.

DS creation takes place in a series of processes based on the components. There are studies that describe the steps of DS creation in different ways. Jakes and Brennan (2005) stated that the first step is writing. In this step, drafts are created and worked on. In the second step, the script is developed. In the third step, the storyboard is prepared and the script is associated with the images. Next, the multimedia tools are located and the DS is created and shared. Lasica (2010) identified the steps as deciding on the story, gathering the necessary materials, developing the script, preparing the equipment, creating the storyboard, digitisation, recording a voice-over, adding music, editing the story, and sharing the story.

Various software and tools are utilised to create and share DS. A well-chosen software program or tool will make the DST process more effective and productive for content developers. There are software programs with many different features for creating DSs. Some software programs are completely free, while others have paid versions. Uğur-Emiroğlu (2021) stated some of these software programs as iMovie, StoryJumper, Movie Maker, ToonDoo, GoAnimate, Make Beliefs Comix, Windows Photo Story 3, Tellagami, Strip Designer, and Powtoon.

DST and Education

DST is an effective technological tool used for various purposes in museums, community organisations, health centres and elsewhere (Robin, 2016). Education is also one of the common areas of use of DST, since DST is a powerful tool created to integrate the latest technology into the classroom. It is said that the reason for its strength is its student-oriented character, because today's students are creative, visual learners who grow up in a multimedia world and approach audio-visual elements in a positive way. Moreover, when students are given the opportunity to tell their stories using DST, they become self-motivated information consumers (Teehan, 2006). Many schools use DST to provide instruction in various courses (Hill & Grinnell, 2014), since DST is a technological application designed to help teachers overcome certain obstacles that prevent them from using technology effectively in their classrooms (Robin, 2008). Furthermore, one of the benefits of DST is its fostering of 21st century literacy skills, which are stated as a critical need for students to learn, work and

progress in today's technology-intensive world (Robin & McNeil, 2019). Moreover, DSs are learning tools that enable students to communicate complex concepts and emotions with the aid of linguistic and non-linguistic modes (Kim et al, 2021). According to Aydın (2019), listening, speaking, reading, technology usage and communication skills develop through DST. It also contributes to achievement, language learning and affective experience (Liu, Huang & Xu, 2018). DST is a valuable tool that develops visual and multimedia literacy in students (Jakes & Brennan, 2005), involves students in the learning process, improves decision-making skills, encourages real-world connections, and encourages students to work in cooperation (Behmer, Schmidt & Schmidt, 2006).

In the literature, it is seen that DSs are used in many fields of education. Some of these are mathematics (Albano & Pierri, 2017; Cemil, 2015), science (Ulum & Yalman, 2018), and language education (Moradi & Chen, 2019). The use of DST in education has an impact on students, preservice teachers, teachers and educators. For students, situations such as academic achievement (Nam, 2017) and attitude (Yang & Wu, 2012) are emphasised, while for preservice teachers, creative writing ability (Duman & Göcen, 2015), DST experience (Aslan & Kazu, 2021), and opinion (Özüdoğru & Çakır, 2021) are some of the topics studied. A wide range of studies have also been conducted with teachers. For example, in her research, Kocaman-Karoğlu (2016) worked on DST practices with preschool students and teachers. After the implementation, the teachers' views were examined. Vivitsou, Niemi, Wei, Kallunki and Miao (2017) designed a study in which primary school teachers analysed DSs prepared by students. In her research, Van Galen (2017) aimed to determine the shame anxieties of teachers working in low-income schools by having teachers create DSs. Del-Moral-Pérez, Villalustre-Martínez and Neira-Piñeiro (2019) investigated teachers' perception of the contribution of collaborative DST to the communicative and digital competencies of children in primary schools. In the study they conducted with teachers, Stenhouse & Schafer (2019) attempted to determine the extent to which teachers defined and represented empowerment in a multimedia capstone project. Özüdoğru (2021), on the other hand, examined teachers' views on the use of DST in education.

Evaluation of DS's

In order to use DS's effectively and productively in education, it is important to make the necessary evaluations. In this way, by creating the opportunity for feedback and revision, the creation of more powerful stories can be enabled. It is seen that rubrics are mostly used in

the evaluation of DS. Rubrics help to ensure that everyone knows the requirements for expectations to be consistent, fair and equitable. They also show people what the task is and how to complete it (Selke, 2013). The rubrics used to evaluate DS have mostly been prepared based on the components of DST. For example, in Barrett's (2006) rubric, point of view-purpose, point of view-awareness of audience, dramatic question, emotional content, voice-consistency, voice-conversational style, voice-pacing, soundtrack-originality, soundtrack-emotion, images, economy, and duration of presentation were referred to. On the other hand, Çıralı-Sarıca and Koçak-Usluel (2016) used the headings of purpose, clarity, language and grammar usage, originality, emotion, sincerity, economy, fluency, organisation, content, integrity, duration, image/video relevancy, image/video effectiveness, voice relevancy, voice pacing, voice quality, music relevancy, music pacing, music-voice volume relevancy, and copyright. In the scale that they developed to assess DS, Özcan, Kukul and Karataş (2016) used the following items: dramatic question, purpose of the story, creating a storyboard, originality/attractiveness, length of the story, economy, use of language and grammar, copyright and ethics, audio, music, multimedia quality, multimedia synchronisation, organisation, and sharing for feedback. Tse, Chan and Chu (2021), on the other hand, referred to point of view-purpose, story organisation, story structure, language use, dramatic questions, written text, images, audio, duration, economy, and creativity.

Considering that the aim is to organise an effective and productive mathematics learning environment, it is thought that as much as the evaluation of DS in a technical sense, it is important for teachers to evaluate DSs, since teachers are the people who are most familiar with the real classroom environment and classroom dynamics. Aagaard (2014) stated that teachers do not have enough professional knowledge related to DS assessment. She also stated that during the evaluations, they were mostly interested in assessing the intertextual, visual and auditory qualities of DSs. It is seen in the literature that studies in which teachers evaluate digital stories without a rubric are limited. It is thought that this study may be important in this respect. However, there are studies in the literature in which teachers' views on the use of DS have been obtained (Karataş, Bozkurt & Hava, 2016). On the other hand, studies in which mathematics teachers evaluate DSs prepared without applying them in the classroom environment are limited. The aim of this study is for teachers to evaluate DSs prepared by preservice teachers for the middle school learning outcomes of the

Ministry of National Education Mathematics Curriculum (2018) and to examine their views on the DS. For this reason, the problems and sub-problems of the research are as follows:

1- How do middle school mathematics teachers evaluate digital stories?

a. What are the features of DSs that middle school mathematics teachers like?

b. What are the features of DSs that middle school mathematics teachers dislike?

c. What are the evaluations of middle school mathematics teachers regarding the appropriateness of DSs for the learning outcomes?

d. What are the evaluations of middle school mathematics teachers regarding the usability of DSs in the classroom environment?

2- What are the views of middle school mathematics teachers on the use of DSs in learning environments?

a. Is there a need to use DSs in mathematics?

b. In which part of the lesson should DSs be used in mathematics lessons?

c. What is the effect of DS use on student achievement?

d. How willing are middle school mathematics teachers to design DSs and use them in classes?

Method

Research Model

The research was designed as a qualitative case study. A case study is defined as an in-depth and multidimensional examination of a single social phenomenon using qualitative research methods (Feagin, Orum & Sjoberg, 1991). In this research, a case study was used, since both middle school mathematics teachers' evaluations of DSs and their views on their use in the learning environment were examined.

Participants

The participants in the research were seven mathematics teachers working in two public middle schools in Turkey. Criterion sampling (Büyüköztürket al, 2012) was preferred for the selection of the sample. Accordingly, the criterion was that teachers should have less than 15 years of experience. The reason for this was that studies on the use of DST in education have intensified in the last ten years (Şimşek, Koçak-Usluel, Çıralı-Sarıca & Tekeli, 2017). In Turkey, the first studies related to DST date back to 2005 (Kocaman-Karoğlu, 2016). The participants in the research were seven middle school mathematics teachers who met

this requirement and were willing to participate in the research. Participants were coded as T1, T2, …T7. Five of the participants were women and two were men. Their years of experience ranged from 5 to 12 years. While six of the participants entered classes in all of the 5th, 6th, 7th and 8th grade levels of middle school, one (T3) entered classes in only the 5th and 8th grade levels. All of the participants stated that they used smart boards in their lessons, while T2 stated that he also made use of the telephone and computer, while T4 stated that she also benefited from the Education Informatics Network (EIN). All of the participants stated that they had not previously heard of the DS concept.

Data Collection Tools

Three data collection tools were used in the study. The first data collection tool was a form designed to determine the participants' demographic characteristics. This tool includes questions about the participant's name, surname, school, gender, years of experience, and in which grade level(s) he/she entered classes. Moreover, an attempt was made to learn whether they used technology in their lessons and whether they had heard of the DS concept before. This form was implemented once at the beginning of the process. Another data collection tool is the "DS Evaluation Form". This form consists of four questions prepared by the researcher after obtaining expert opinion and scanning the literature. The form includes the questions, "What are the features you liked in the DS you watched?", "What are the features you disliked in the DS you watched?", "Is the DS you watched appropriate for the learning outcome?" and "Is the DS you watched suitable for use in the classroom?". Each teacher was asked to fill in this form for each DS watched. Finally, semi-structured interviews were conducted with each teacher and audio recordings were made. In the interviews, participants were asked questions on whether there is a need for DSs in mathematics, in which part of the lesson DSs can be used, the effect of using DSs on student achievement, and whether they wished to design and use DSs in their classes. The duration of the interviews varied between 10 and 18 minutes.

Procedure

After obtaining the necessary permissions for the research, a meeting was held with the mathematics teachers and information was given about the subject and scope of the research. The research lasted for 10 hours over a two-day period. On the first day, the teachers were asked to fill in the demographic information form in order to determine their

demographic characteristics. Then, information about DST was given for one hour and sample DSs were watched. Next, a total of 252 DS evaluation forms, 36 of which were given to each teacher, were handed out. After the learning outcome and DS number were read out by the researcher, the DS was shown to all teachers at the same time with the aid of a projector. After the viewing, they were given time and asked to fill in a separate form for the DS that they had watched. In this way, the 36 DS were examined. Finally, at the end of the second day, individual semi-structured interviews were conducted with each teacher.

About DSs

The examined DSs were prepared by 40 preservice middle school mathematics teacher 2nd grade students for the learning outcomes of the middle school mathematics course These stories were prepared as part of a one-semester course at the faculty of education. During the course, preservice teachers designed a digital story twice, individually and in groups. The definition of digital story, its components, preparation stages and the software that can be used were introduced in the course. The advantages and disadvantages of using digital stories in mathematics education are discussed in the light of the literature. In-class story setups were made and transferred to digital. In addition, sample digital stories were watched. The stories of the preservice teachers were discussed in class and feedback was given. Later, they were transferred to digital. At the end of the term, a total of 60 digital stories were obtained. These stories were evaluated by two experts in terms of technique, suitability for learning outcomes, being free from errors, and usability. At the end of the process, 36 digital stories were selected to be used in this research.

Data Analysis

A semi-structured interview form and semi-structured interviews were used in the research. Content analysis (Krippendorff, 2018) was used for the analysis of the data. Data are shown as codes, categories and frequencies. In addition, quotations from the responses given by the teachers to the form and interview are presented. Coding was done by the two researchers. Miles and Huberman (1994) stated that intercoder reliability is achieved for agreement of 80% or more, and in this study, the intercoder reliability coefficient was calculated as 87% (for the total interview question).

Findings

The findings are presented under two main headings in line with the research problems.

Findings Regarding Middle School Mathematics Teachers' Evaluations of DSs

Findings related to the first research problem were obtained by separately examining the 36 DS prepared for the learning outcomes of the middle school mathematics course. The data on middle school mathematics teachers' evaluation of DSs were analysed and gathered under four headings. These are "Findings regarding the features of DSs that middle school mathematics teachers liked", "Findings regarding the features of DSs that middle school mathematics teachers disliked", "Findings regarding middle school mathematics teachers' evaluation of the appropriateness of DSs for the learning outcomes" and "Findings regarding middle school mathematics teachers' evaluation of the usability of DSs in the classroom environment".

Findings regarding the features of DSs that middle school mathematics teachers liked

Five categories were obtained from the analysis of the teachers' data on the features of DS that they liked, and these categories are presented in Table 1:

Table 1. Categories and codes for features of DSs that teachers liked

Categories	Codes	*f*
No features liked	None	39
The whole story	Everything	3
DST components	Image	31
	Story	20
	Music	16
	Voice	6
	Pacing	2
	Dramatic question	1
Mathematical features	Example	55
	Activity	39
	Idea	28
	Daily life-mathematics relationship	28
	Topic	11
	Expression	6
	Representation	6
	Description	5
	Concept	3
	Explanation	3

Contribution to learning process	Being interesting	19
	Comprehensibility	13
	Simplicity	6
	Enabling discovery	5
	Making a comparison	4
	Having a recap section	3
	Fluency	3
	Using questions at the end	2
	Concretisation	2
	Being entertaining	2
	Being thought-provoking	1
	Encouraging participation	1
	Facilitating learning	1
	Enabling analogy	1
	Catchiness	1
	Highlighting important parts	1
	Being absorbing	1
	Being motivating	1

As can be seen in Table 1, 39 views are related to the absence of a feature that was liked in the DS, while there are three views to the effect that the whole story was liked. When the DST components category is examined, it is seen that the teachers liked the images and the story the most. Some of the teachers' views are presented below:

"The story and images are very nice" (T1/ Story/Image).

"The vocalisation of the grandfather and grandmother in the material was very good and realistic" (T2/ Voice).

"I liked the pizza slice visually" (T2/ Image).

"The song of π was very good. I heard it for the first time, and it impressed me…" (T3/ Music).

"I liked the wide variety of images" (T6/ Image).

"I liked the use of the compass image, the demonstration of drawing a circle, and the music" (T7/ Image/Music).

"…The transition speed was appropriate, neither too fast nor too slow" (T7/ Pacing).

In the category of mathematical features, the example, activity, idea and daily life-mathematics relationship features were liked the most. Some of the teachers' views are presented below:

"I liked the example very much because the sugar cube box is something that every child can easily see in every home" (T1/ Example/Daily life-mathematics relationship)

"I liked the fact that the example used in the story was chosen from daily life" (T2/ Example/Daily life-mathematics relationship)

"By utilising a game, it explained correctly and very nicely that a triangle has no diagonal"(T2/ Activity/Explanation).

"The use of concepts such as temperature and heat were nice" (T3/ Concept).

"Creating a gift box is a good idea" (T4/ Idea).

"It explained very well why the graph was necessary…" (T5/ Explanation).

"It was very logical to express the bar graph with the Lego example; I can use it in my lessons" (T5/ Example/Expression).

"…The idea of a painting competition around the field was very nice" (T6/ Idea).

"I liked the fact that it was expressed in stages" (T6/ Expression).

"The description was nice, and the representation of the measurements was nice" (T7/ Description/Representation).

"I liked the fact that it mentioned social issues such as extracurricular cooperation" (T7/ Topic).

"…I liked the representation of the diagonal with the sticks in the frame" (T7/ Representation).

"Asking riddles and putting them in games and supporting them with objects we use in daily life..." (T7/ Activity/Daily life-mathematics relationship).

In the category of contribution to the learning process, the fact that DSs were interesting and understandable was emphasised the most. Some of the views regarding this category are presented below:

"I liked the fact that the story prepared for the line, ray and line segment was catchy" (T1/ Catchiness).

"This was one of my favourite materials. …Also, it was nice that it compared the two fields and found the same result… It was also very fluent" (T2/ Making a comparison/ Fluency).

" …It was nice that it likened parallel lines to the strings of a guitar" (T3/ Making an analogy).

"The story was interesting. Especially, the teaching of the local subject was very successful" (T3/ Being interesting).

" …The story was clear and understandable…" (T5/ Comprehensibility).

"The use of games in the subject was interesting and absorbing" (T5/ Being interesting/Being absorbing).

"The fact that the material is colourful and lively will attract students' interest. Moreover, the fact that it is auditory increases the effect" (T6/ Being interesting).

"Since it is simple, it does not lead to conceptual confusion" (T7/ Simplicity).

"The musical accompaniment makes it entertaining" (T6/ Being entertaining).

"It's nice that the child says 200 ml is written on the small milk cartons and goes to 1 litre by discovering it himself" (T7/ Enabling discovery).

"Emphasising the equal spacing part in the bar graph, supporting it with an example question at the end, and attracting interest with Lego bricks..." (T7/ Emphasising important parts/Using questions at the end/Being interesting).

"Comparison of what three different people have achieved with developments…Interesting" (T7/ Making a comparison/ Being interesting)

Findings regarding the features of DSs that middle school mathematics teachers disliked

Four categories were obtained from the analysis of the teachers' data on the features of DSs that they disliked, and these categories are presented in Table 2:

Table 2. Categories and codes for the features of DSs that teachers disliked

Categories	Codes	*f*
No features disliked	None	12
DST Components	Image	52
	Pacing	30
	Voice	29
	Length	23
	Language and grammar	15
	Synchronisation	12
	Story	2
	Economy	1
Mathematical features	Error	31
	Example	31
	Description	17
	Expression	17
	Number selection	17
	Unit	16
	Concept	14
	Deficiency	14
	Process	11
	Content	11
	Representation	10
	Explanation	9

	Inappropriate for learning outcome	4
	Term	3
General features	Complicated	27
	Boring	7
	Difficult	7
	Not instructive	6
	Loss of time	4
	Distracting	4
	Monotonous	3
	Immobile	3
	Not interesting	2
	Not motivating	1
	Not creative	1
	Illogical	1
	Not exploratory	1

As can be seen in Table 2, 12 opinions are related to the absence of a disliked feature in the DSs that were watched. In the category of DST components, it is seen that the images, pacing and voice codes are common. Below are some of the views regarding this category:

> *"There were a lot of speaking parts in the story, and the story was quite long…" (T3/ Length)*
>
> *"While it explained the right angle very well, it could not support the wide and narrow angles with images" (T5/ Image)*
>
> *"The conversations in the story progress very quickly, and considering the perception level of 5th grade students, the rapidity of the conversations has a negative effect on learning" (T3/ Pacing).*
>
> *"There are too many typos in the story, and the voice and image synchronisation are problematic" (T6/ Language and Grammar/Synchronisation).*
>
> *"The story was not supported by images, and the arrangement of the candies in the box could have been shown" (T6/ Image).*
>
> *"There could have been a voiceover, the speech bubbles go by too fast, and the students can't keep up" (T6/ Voice/Pacing)*

In the mathematical features category, it is seen that the example and error codes are mostly found. Some of the views regarding this category are presented below:

> *"The wrong expression was used when going to m-dm-cm-mm while saying that the operation is done with 1000" (T5/ Error).*
>
> *"…The drawings of the views of the objects from different sides were wrong"(T6/ Error).*

"It is explained as if 1 cm3 is equal to 1 cubic unit. There is an error" (T1/Error).

"… the numbers used are too big, not suitable for a 5th grade student" (T3/ Number selection).

"Examples of which ones are used in what kinds of situations in daily life could be increased" (T7/ Example).

"A research question is not asked to a single person; it is asked to a group" (T5/ Error).

"This material seems to be inappropriate for the outcome; it is not relevant to the subject" (T2/ Inappropriate for learning outcome).

"…it is wrong to say that all of the answers are correct for the wrong answers of the children in the views..." (T7/ Error).

"Multiplication in decimal notations is not related to the outcome… For example, there were parts that needed to establish the correct ratio, but this outcome has not been given to 5th graders yet" (T3/ Inappropriate for learning outcome)

"…There are formal deficiencies; the shapes could be drawn better" (T4/ Deficiency)

In the general features category, the boring and difficult codes are mostly found. Some of the views regarding this category are given below:

"There is a lot of information overload because the areas of many shapes are found and collected at the same time. I found it confusing" (T1/ Complicated).

"A hand-made figure is not interesting on the screen" (T5/ Not interesting)

"Since a 5th grade student has difficulty in thinking in three dimensions, it can be confusing for three friends to describe the views of the same object at different points" (T5/ Complicated).

"It makes more sense to give views of the shapes from different directions together because the concept of symmetry is mentioned. However, it is difficult for the student to discover whether the shapes are symmetrical without seeing them" (T5/ Not exploratory).

Findings regarding middle school mathematics teachers' evaluation of the appropriateness of DSs for the learning outcomes

The analysis of the data on the appropriateness of DSs for the learning outcomes is presented in Table 3:

Table 3. Codes for the appropriateness of DSs for learning outcomes

Category	Codes	*f*
Degree of appropriateness for outcome	Appropriate	152
	Appropriate but should be revised	46
	Inappropriate	54

As can be seen in Table 3, views were mostly obtained to the effect that DSs are appropriate for the learning outcomes. Some views are that DSs are appropriate for the outcomes but should be revised. Some of the views are given below:

> *"It is appropriate for the outcome. It was correct to first calculate the area with unit squares" (T4/ Appropriate).*
>
> *"The material is not appropriate for the outcome; it is made unnecessarily difficult" (T2/ Inappropriate).*
>
> *"It's appropriate for the outcome, but it's too long. It can be shortened a little, and examples should be increased" (T7/ Appropriate but should be revised).*

Findings regarding middle school mathematics teachers' evaluation of the usability of DSs in the classroom environment

The views on the usability of DSs in the classroom environment were analysed and are presented in Table 4:

Table 4. Codes for the usability of DSs in the classroom environment

Category	Codes	*f*
Usability in the classroom environment	Suitable	102
	Suitable but should be revised	65
	Not suitable	85

As can be seen in Table 4, there are mostly codes indicating that DSs are suitable for use in the classroom environment. Below are some of the teachers' views:

> *"They are suitable for use in the classroom environment. The material is useful and motivating" (T1/ Suitable).*
>
> *"They can be used in the classroom environment, but as I mentioned before, the conversations should be simplified. The speeches may be rather heavy for 5th graders" (T2/ Suitable but should be revised).*

"They are not suitable. I prefer to teach the subject in the classroom with concrete materials, for example, by using unit cubes" (T5/ Not suitable).

Findings Regarding Middle School Mathematics Teachers' Views on the Use of DSs in Learning Environments

This section includes the findings from the interviews with the teachers. The views of the middle school mathematics teachers on the use of DSs were analysed and are presented under four headings. These are "Findings regarding the need to use DSs in mathematics", "Findings regarding in which part of the lesson DSs can be used in mathematics lessons", "Findings regarding the effect of using DSs on student achievement" and "Findings regarding the willingness of middle school mathematics teachers to design DSs and use them in lessons".

Findings regarding the need to use DSs in mathematics

All participants (f=7) stated that there was a need for the use of DSs in mathematics. Extracts from the interviews with the participants are presented below:

"Now they are very usable in fifth and sixth grades, and sporadically in seventh grades. So fifth grade is very suitable for this. However, despite this, sometimes there is a problem in keeping up with the subject in terms of time. There is a need for DS, but to change the way the lesson proceeds, so as not to keep the student in the same mode all the time, because students are now the new generation of students. They get really bored in mathematics class. You constantly give information-based things, you teach, you start problem solving straight away, and some students get bored with it. … In this way, they like to add different images to the lesson, to watch videos, and I find it appropriate to use these in such a way" (T4).

"Of course, DS have to be used because now we need to move away from traditional methods, we have to keep up with the times. In mathematics, something new appears every day; there are new practices. Now we have to adapt to these and I think it will be very nice. We already have a smart board system, and this is a very good base for DSs; I think it can be very useful" (T6).

Findings regarding in which part of the lesson DSs can be used in mathematics lessons

Data on which part of the lesson DSs can be used in were analysed and are presented in Table 5:

Table 5. Categories and codes regarding which part of the lesson DSs can be used in

Category	Codes	*f*
Part of the lesson	At the end of the lesson	6
	In the necessary parts	4
	During the lecture	4
	At the beginning of the lesson	2
	While giving examples	1
	While summarising	1

As can be seen in Table 5, teachers mostly had opinions about using DSs at the end of the lesson. Extracts from the interviews are presented below:

> *"Now some materials can be used to increase student motivation in the introduction part of the lesson, but some are for revision at the end of the lesson. So it can be used at the beginning, at the end, and in the middle of the lesson. I don't want it to enter the time frame at the end of the lesson, it can be used at any time" (T2).*
>
> *"I found some of them suitable for the introductory part. The pizza story, for example. It taught reverse angles. It can also be used throughout the course, because it explains the subject well. For the line graph, there was the farm example. That can also be used throughout the course, because the line graph will be explained once. It is also fully explained with that. The next step is reinforced by the teacher's example. Some of them were also good to listen to in the first part in order to draw attention. For example, after the teacher has explained the subject well and reinforced it for the students, there are DSs that could be used for revision in the last part" (T4).*
>
> *"It is actually more logical to use them at the beginning of the lesson in order to benefit the lesson, but there are just a few examples and materials that we could use at the beginning of the lesson. Others can also be used for revision at the end of the lesson. However, for the materials that can be used at the beginning of the lesson, it is more logical to use them at the beginning of the lesson, in order to attract the attention of the student, to motivate the student" (T5).*

Findings regarding the effect of using DSs on student achievement

Data on the effect of using DSs on student achievement were analysed and are presented in Table 6.

Table 6. Categories and codes regarding the effect of using DSs on student achievement

Category	Codes	*f*
Degree of effect on achievement	They will increase it	4
	They will have no effect	3

In Table 6, it is seen that teachers mostly stated that the use of DSs would increase student achievement. Some of the teachers' views on this sub-problem are as follows:

> *"…First of all, they increase the student's attention, motivation and interest. For this reason, their achievement will also definitely increase" (T2).*
>
> *"I think they can increase success because especially in mathematics, our greatest shortcoming is that the student comes to the lesson with a prejudiced approach. You just know, the 5th, 6th and 7th grades are the ages when abstract thinking is just beginning. That's why I think it would be helpful for them if we could show things concretely. For this reason, I believe that their success will increase" (T3).*
>
> *"Success does not increase with a three-minute video. You only attract the student's attention. What will happen is that there will be a more colourful lesson delivery. In other words, the student will think that the teacher doesn't just go to the blackboard, he makes me watch a visual, there is a voice, there is music, and he should have a look... But of course, it is impossible to increase success with just a three-minute video. First of all, it is necessary to think about the factors behind success. For a student to be successful in a course, the subject must be well reflected to him. The student's readiness for this is important, and there are things to be done afterwards, such as problem solving. The number of problems you can solve and the number of examples you can give in a three-minute video is not enough, but I think it is encouraging" (T6).*

Findings regarding the willingness of middle school mathematics teachers to design DSs and use them in lessons

All of the teachers (f=7) stated that they wished to design DSs and use them in their lessons. Below are examples of teachers' views:

"We didn't have a class like this when I was at university; I wish we had, and we could have learnt it too. As I said, we give examples to students, but since we could not bring those examples to life, this would have been very useful for me as I could not convey what goes through my mind, the way I think, to the student. I would definitely use this to reflect my thoughts on students, to reflect how I think about a story to students. I wish I could learn it, if I knew, I would say I could use it too" (T5).

"I would definitely like to use it. I also want to create a product myself, it would be great if we could learn it, because you are becoming a bit more conscious now and you can see that some things can be much more useful for students. Since we know the situation in the classroom much better, we can produce better products. Of course, this also requires work for us, so we also have to learn, and we have to work hard on it so that good products can emerge" (T7).

Discussion and Conclusion

Experiences in developing, industrialised and knowledge-based countries around the world show that training teachers in technology use and implementation is the main determining factor in improving student performance. For quality education, teachers who can integrate technology into the curriculum and use it to improve students' learning are required (Wang & Hartley, 2003). Described as a technological tool, DST is important in terms of enabling an interesting learning experience. DST encourages schools to answer the questions of what learning is and how technology can be used to support the conditions necessary for learning to take place (Banaszewski, 2005). Therefore, it emerges as a tool that should be discussed and implemented in teacher education.

In this research, the aim was for teachers to evaluate digit DSs prepared by preservice teachers and to examine the teachers' views about the use of DSs in learning environments. As a result of the research, it was seen that in terms of DST components in DSs, mathematics teachers liked the images the most. In addition, in the research, images were also one of the most repeated codes among the features that were disliked. The ability of students to express themselves through visual media instead of words facilitates communication for students and increases their confidence (Smeda, Dakich & Sharda, 2014). Mathematics is a field in which there are abstract concepts. Therefore, in mathematics, visuals and visualisation are of great importance for concretising the subjects. Moreover, visualisation also has benefits such as drawing the attention of the student, motivating the student, making learning meaningful,

the student's organisation of his/her own knowledge, and his/her association of the concrete and abstract expressions of concepts (Gökbulut, Sidekli & Sayar, 2013). Therefore, good selection and use of images in DSs is important in terms of correctly conveying what is intended to be explained and providing benefits for students' learning. Another of the features that were liked was the stories themselves. Establishing communication is one of the most basic human needs. Throughout history, stories have been used to meet this need. For the content created in new communication environments to be of good quality, it must be user-oriented (Ökmen & Çokluk, 2021). The fact that one of the most liked features of the DSs was the stories themselves is an indication that they are an important step in addressing the target audience. It was also seen that in terms of mathematical features, the examples and mathematical activities used in DSs were liked. In addition, the idea in the story and the daily life-mathematics relationship were also among the features that were liked. Preservice teachers who can associate mathematics with daily life give students the opportunity to see the relationships between concepts and to use the concepts by combining them with other concepts. Considering the constructivist learning approach, it is very important to design learning activities aimed at making mathematical associations in the mathematics learning-teaching process (Çenberci & Özgen, 2021). Furthermore, some of the general objectives sought to be achieved in the Mathematics Curriculum (MoNE, 2018) are expressed as that "the student will be able to understand mathematical concepts and use these concepts in daily life", and "the student will be able to give meaning to the relationships between people and objects and the relationships of objects with each other by using the meaning and language of mathematics". Therefore, it is thought that the DSs that are prepared will address this purpose. In the category of contribution to the teaching process, the interesting and understandable qualities of DSs were also among the most liked features. The findings that DSs were entertaining (Şimşek et al., 2017), eye-catching and encouraging active participation (Kocaman-Karoğlu, 2016), and motivating and absorbing (Kukul & Kara, 2019) overlap with the findings of this research.

The most disliked features of DSs were their errors and the examples used. Mathematics is a subject that is taught in stages. Therefore, errors can lead to incorrect learning and even to incorrect generalisations. For this reason, ensuring that DSs are free from mathematical errors is seen as an element that needs to be addressed and emphasised alongside technical issues. When the general characteristics were examined, it was seen that

the stories were not liked for reasons such as being complicated, boring and difficult. From this point of view, it can be thought that teachers want DSs to have features such as being uncomplicated, entertaining and easy.

While it was determined that most of the DSs were prepared in accordance with the learning outcome, it was emphasised that some stories were appropriate for the learning outcome but that some revisions had to be made. Considering their usability in the classroom, it was determined that the DSs were mostly suitable for use in the classroom. It is stated in the research that rubrics are used for the evaluation of DSs. However, beyond these evaluations, the classroom climate is also very important. A very good DS in a technical sense may not be effective enough because it is not suitable for the class. In this respect, it is important to evaluate the usability of DSs in the classroom.

Albano and Iacono (2019) mentioned in their research that when evaluating DS, mathematics teachers mostly focused on affective elements such as motivation and neglected cognitive elements such as content, definitions, properties and theorems. In this study, it was determined that teachers expressed more opinions about mathematics-related features in both the liked and disliked features, and that they paid more attention to mathematics than technical and affective subjects. Aagaard and Silseth (2017) stated that teachers mainly focused on verbal messages in evaluation. However, they also stated that teachers tended to expect DSs to have similar content and features to traditional oral school texts. In this study, it was observed that teachers focused not only on verbal messages, but also on mathematical content and components in evaluation.

When the interviews with the teachers were examined, all of the participants stated that there was a need for DSs in mathematics. Robin and Pierson (2005) stated in their research that they had (wrongly) assumed that it would be more difficult to interest mathematics and science teachers in using DSs in their own content areas than in more visually-focused areas such as history, writing and art, but that as a result of the research, this did not occur. The fact that all teachers in this study thought that there was a need for DSs in mathematics is in line with the findings of Robin and Pierson (2005). It was determined that there were different opinions about which part of the lesson DSs could be used in. However, the teachers mostly stated that it was appropriate to use them at the end of the lesson. Although four teachers were of the view that DSs would increase student success, three teachers expressed the view that their use would not affect success. There are

also studies in the literature (Bilen, Hoştut & Büyükcengiz, 2019; Yang & Wu, 2012) in which DSs increased student achievement. All of the participants who took part in the research stated that they wished to design and use DS. This finding shows similarity with the research by Yılmaz, Üstündağ, Güneş and Çalışkan (2017).

Recommendations

✓ In this study, the mathematics teachers evaluated DS individually. Conducting a collective evaluation is offered as a suggestion in terms of providing more detailed and in-depth information.

✓ It can be suggested as a suggestion to get more support from teachers who have mastery of classroom dynamics during the design of digital stories.

✓ While designing digital stories, it can be suggested that more emphasis should be placed on the elements of suitability for learning outcomes and usability in the classroom environment.

✓ In case of teachers' willingness to prepare digital stories and use them in their lessons, in-service training can be offered as a suggestion.

✓ Instead of individually designing digital stories for teachers, a database can be created so that they can use appropriate digital stories for themselves.

Ethics Committee Permit Information

Name of the board that carries out the ethical evaluation: Kafkas University Ethics Committee

The date of the ethical assessment decision: 27.05.2021

Ethical assessment document number: 20

Author Contribution Statement

***Ruhşen ALDEMİR ENGİN**: Conceptualization, methodology, implementation, data analysis, review-writing and editing.*

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Addition: Examples of digital stories

Digital story 1: Cansu and her mother go to the carpenter to make a work table for Cansu. Cansu wants a rectangular table. Between Carpenter and Cansu, there is the issue of sticking the table legs to the wood. The carpenter says it should be done with a right angle, but Cansu does not know what a right angle is. The carpenter explains using squared paper and a miter. When they take the table and go home, she notices that the table is shaking. They go to the carpenter again and check the legs of the table. The carpenter realizes that he is using a wide angle by measuring with a miter. After he makes the necessary corrections, she notices that the table is shaking again. The carpenter measures again, indicating that he is using an acute angle. Finally, he forms the right angle and Cansu happily uses the table.

A picture of digital story 1 is given in Figure 1:

Figure 1. A picture of digital story 1

Digital story 2: In this digital story, a dialogue is given between a mother and her son who want to buy a rectangular carpet, but when she comes home, she realizes that she has bought a parallelogram cut carpet. Upon the mother's dismay, the son cuts the parallelogram-shaped carpet and sticks it on the other side and turns it into a rectangular shape. Here, how to calculate the area of the parallelogram with the help of the area of the rectangle and the relationship between the rectangle and the parallelogram are given.

A picture of digital story 2 is given in Figure 2:

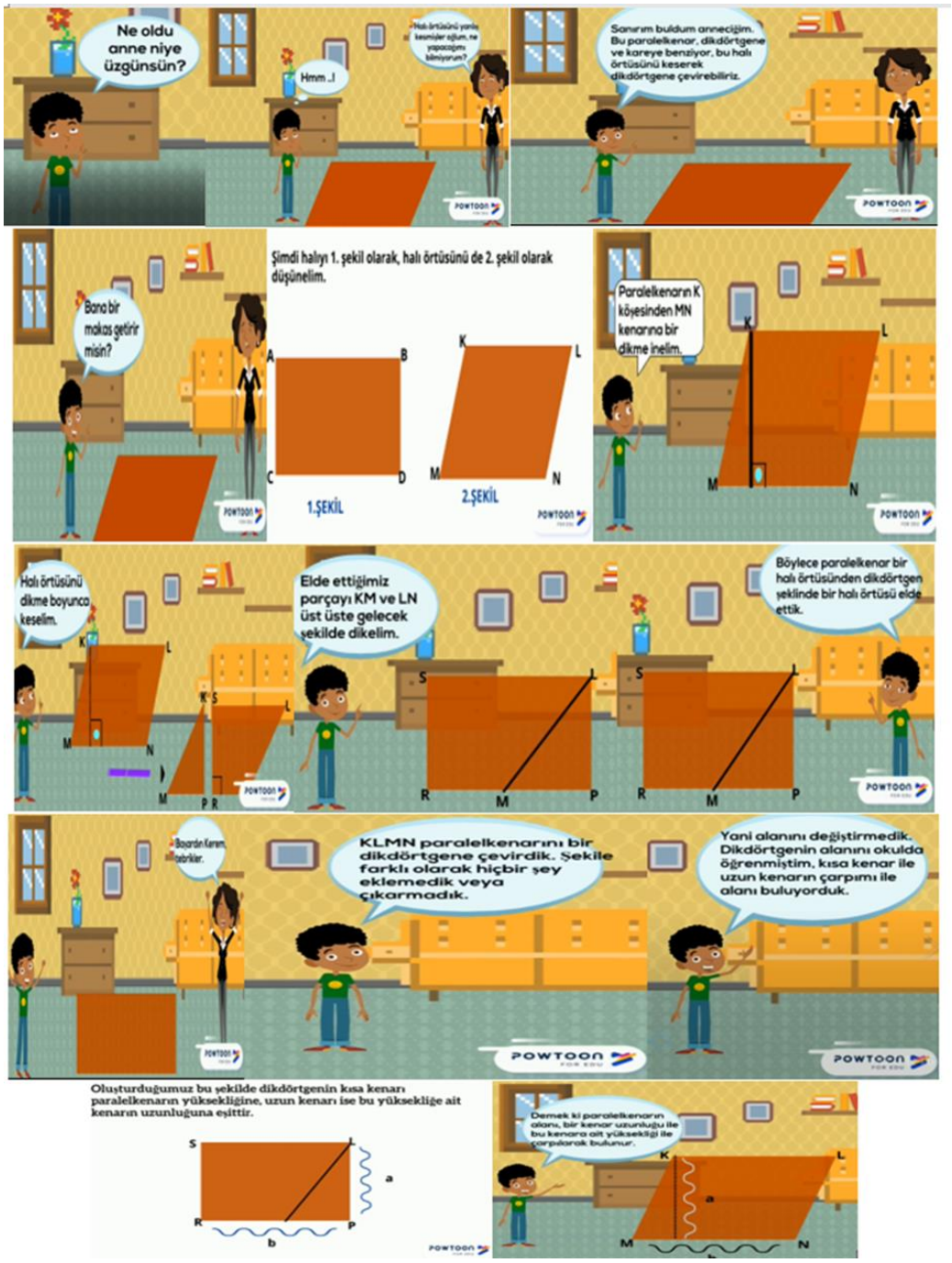

Figure 2. A picture of digital story 2